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An Empirical Study of Supply Response: Cash Crops in China

by

Chuanliang Su

A PAPER

SUBMITTED TO THE DEPARTMENT OF RURAL ECONOMY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF AGRICULTURE IN AGRICULTURAL ECONOMICS

DEPARTMENT OF RURAL ECONOMY

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DEPARTMENT OF RURAL ECONOMY

The undersigned certify that they have read and recommend to the Department of Rural Economy, for acceptance, a paper entitled **An Empirical Study of Supply Response: Cash Crops in China** submitted by Chuanliang Su in partial fulfillment of the requirements for the Degree of Master of Agriculture in Agricultural Economics.

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Dated 10 October 1990

Abstract

Research on supply response of agricultural products has provided information useful in development of agricultural policies in many countries. However, studies in this area have been lacking in China since little response in farmers' decisions to economic factors was expected due to the tight control of Chinese government over agriculture, which applied from 1949 until recent years.

Chinese agriculture has been under control of government since 1949 when the Chinese Communist Party came to power. The rural economic reform gradually increased since 1979 was associated with a release of control of government. The economic reform fostered the development of Chinese agriculture and improved the living of Chinese peasants. However, some Chinese, especially the old guards of the Party, have been unsatisfied with the reform and have wanted to suspend this and employ traditional central planning and political education to achieve economic development. Others have argued that market-oriented economic policy has to be used to develop the national economy. This study attempts to assess the aggregate impact of both economic influences and government policy on output of cash crops through analysis of aggregate supply functions.

The paper reports an empirical study of cash crop supply response in China. The time period covered is from 1952 to 1971 when Marxist political ideology was strong in China and Chinese agriculture was under the tight control of government. Nerlove's partial adjustment model is used to analyze aggregate annual time series data, using the method of ordinary least squares.

Both short-run and long-run elasticities of area with respect to price ratios (or producers' prices) are found to be significant and are relatively large for all cash crops included in the study except for cotton. This implies considerable sensitivity of Chinese farmers' decisions to

changes in relevant economic factors. Nevertheless, the area of cash crops planted appears to have been highly affected by the government control, as shown by significant estimates of coefficients of a policy variable.

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I Introduction

Assessment of the effects of technical change and agricultural price policy are two important areas for research on agricultural development. Technical change is well recognized as an important factor for agricultural development. Price policy may be important in itself and provide incentives for technical change. Indeed economists tend to agree that a positive price policy for agriculture may be desirable to speed the growth rate of agriculture and national economy. As Krishna (1967) argued: "***Favourable price movements can speed up the diffusion of innovations, the absorption of new inputs, the utilization of idle capacity, and even institutional adjustment. Unfavourable movements can slow down or arrest all these processes***." Knowledge of relationships between price and quantities of farm products are important to the design of appropriate agricultural policy. Price policy can have important effects on quantities supplied.

1.1 Background of the Study

Under the centrally-planned economy of China, price levels and the quantity of production of agricultural products were tightly controlled and did not respond to each other, especially for the period from the 1950's to the early 1970's when Marxist political ideology was strong in China. This ideology provided the foundation underlying the centrally-planned economy of China, the socialist economic system, which is characterized by the collective and national ownership of the economy without political oppression and economic exploitation, according to the political standards of the Communist Party of China at that time. However, from the experience based on political movements for about twenty years, the importance of economic development became recognized since the mid-seventies. Economic reform in rural

areas was introduced in China in 1979. This featured initiating incentives and more freedom for farmers to make decisions on production and marketing of agricultural products. Control over prices of agricultural products and areas of crops planted has tended to be released over time. The economic-oriented agricultural policy and the increase in economic awareness of farmers have led to changes in cropping patterns and production levels as relative prices have changed.

1.2 Problem Identification

Although the rural economic reform in China has been highly successful in raising the level of living of Chinese peasants, it did not necessarily meet the political goals of some Chinese, especially some senior statesmen and older members of the Party. Debate over the nature of the path, socialist or capitalist, the Chinese were taking has been the most controversial issue since 1979. The Chinese faced two alternatives: (1) suspending the economic reform and taking political education and central planning as major means to develop economy, which was done in the period of 1950's to the early 1970's; (2) continuing economic reform and taking market-oriented economic policy as major means to develop economy. The former approach is based on belief in the non-selfish nature of human beings and on the argument that political education and central planning are needed to develop Chinese economy. However, others have argued that market-oriented economic policy is crucial to the development of Chinese economy since the people respond to economic factors in their decision-making. The problem underlying this paper is to assess the extent to which how individuals' economic decisions were affected by central planning and changes of relevant economic factors.

1.3 Objective of the Study

The cash crops included in this study are cotton, tobacco, hemp and jute, sugar beet and sugarcane. The objective of the study is to estimate aggregate cash crop area response

equations in order to assess: (1) how farmers' decisions responded to the relevant economic factors, price ratios or producers' prices; (2) how government control over agriculture affected farmers' decisions relating to the cash crops planted. It is hoped that results of the study may aid in assessing the outcome of Chinese agricultural policy and aid in formation of agricultural policy in the future.

1.4 Scope and Organization of the Study

Annual data from 1952 to 1971 are used in testing single equation models of area response for individual cash crops. The period of 1952 to 1971 represents the period when areas of crops planted and levels of relevant prices were under the strong control of Chinese government over agriculture. Nerlove's partial adjustment model is employed in the analysis and ordinary least squares is used to test the single equation models of area response for the five individual cash crops.

In addition to relative prices, a policy variable is employed in this empirical study to represent the control of the Chinese government over agriculture. The current percentage of cash crops to the total area of crops planted (PAC_t) is taken to represent the effect of direct controls of government over areas of crops planted at macro-level.

For the period from 1952 to 1971, areas of all individual cash crops studied were found to be very sensitive to changes of relevant prices, which indicates that economic factors affected farmer's decisions on areas of crops planted even under the centrally-planned economy of China. The highly significant estimates of coefficients of the policy variable, PAC_t, also suggests the effect of strong control of government over Chinese agriculture.

This report consists of six chapters. Background information on this study is given in Chapter Two. This information includes an overview of the history of policy and development of Chinese agriculture through the period from 1952 to 1985 with focus on the evolution of

political ideology of the Chinese Communist Party and changes in attitude in China toward economic development. This background is given because government policy played a crucial role in the development of the national economy and Chinese agriculture and the policy was much affected by politics under the centrally-planned economy of China, especially for the period from 1949 to 1971.

Chapter Three presents an overview of relevant literature and theory. The chapter consists of two sections. Development of supply response theory from the 1930's to the 1980's is discussed in the first section. This includes discussion of the cobweb theorem (Ezekiel, 1938), the partial adjustment model (Nerlove, 1958) and the hypothesis of rational expectations (Muth, 1961). The second section provides a classification of studies of supply response of agricultural products.

Chapter Four consists of three sections. Models used in this study and justifications for the economic and policy variables used under the context of Chinese agriculture are provided in section one. Data and their sources are discussed in section two. Section three presents the estimation procedures.

In Chapter Five, the econometric estimates of models using the ordinary least squares technique are summarized and interpreted. Major indicators of results are presented, including estimated coefficients and their associated t-ratios, R-square, short-run and long-run elasticities, and results of tests on homoscedasticity and autocorrelation.

Chapter Six provides a summary of the results discussed in the preceding chapter and conclusions based on the results. Problems of the study are discussed and recommendations for further study on this topic are made in the last section of the chapter.

II A Brief Review of Development and Policy of Chinese Agriculture, 1949-1985

As was mentioned in Chapter One, this review of development and policy of Chinese agriculture emphasizes changes in political ideology in China from 1949 to 1985. This is because political ideology rather than economic laws has, for much of this time, underlain the economic policy for agriculture and the national economy. Policy development and growth in the Chinese economy may be more sensitive to changes in politics than in many other countries.

2.1 Development of Chinese Agriculture Since 1949

China is feeding over a billion people, which accounts for more than one-fifth of the world's population, on 7 percent of the earth's arable land. China has tried to be self-sufficient in food-production. However, Chinese agriculture today is still characterized by low technology and labour-intensive production.

Table 2-1 shows the change in annual output of major products of Chinese agriculture since 1949 when the new China was founded. Grain, cotton and edible oils, the daily necessities of living, were in shortage from the 1950's to 1970's, which was reflected by ration coupons from the government. The Chinese government had tried to solve the problem through either institutional changes or political mass movements. But the productivity of Chinese agriculture had not been increased a great deal until the economic reform in 1979. In particular, the increase in production of food and other necessities could not catch up with the increase in the Chinese population, which made the problem of supply shortages even worse and led, with other factors, to the current population policy of birth control. The rate of annual increase of grain production was 3.86% on average from 1952 to 1985, 3.44% from 1952 to 1978, and 3.05% from 1978 to 1985. But the annual increase in the output of grain was 6.73 million tons on average from 1952 to 1985, 5.63 million tons from 1952 to 1978, and 10.62 million tons from 1978 to 1985. The higher rate of annual increase in grain production from 1952 to 1978 was

Table 2-1.

Total Annual Output of Major Agricultural Products (10,000 tons), 1949-1985

year	Total grain production	Total cotton production	Edible oil crop production	Total meat[1] production
1949	11318	44.4	256.4	220.0
1950	13213	69.2	297.2	n.a.
1951	14369	103.1	362.0	n.a.
1952	16392	130.4	419.3	338.5
1953	16683	117.5	385.6	n.a.
1954	16952	106.5	430.5	n.a.
1955	18394	151.8	482.7	n.a.
1956	19275	144.5	508.6	340.0
1957	19505	164.0	419.6	398.5
1958	20000	196.9	477.0	n.a.
1959	17000	170.9	410.4	n.a.
1960	14350	106.3	194.1	n.a.
1961	14750	80.0	181.4	n.a.
1962	16000	75.0	200.3	194.0
1963	17000	120.0	245.8	n.a.
1964	18750	166.3	336.8	n.a.
1965	19453	209.8	362.5	551.0
1966	21400	233.7	n.a.	596.0
1967	21782	235.4	n.a.	n.a.
1968	20906	235.4	n.a.	n.a.
1969	21097	207.9	n.a.	n.a.
1970	23996	227.7	377.2	596.5
1971	25014	210.5	411.3	n.a.
1972	24048	195.8	411.8	n.a.
1973	26494	256.2	418.6	n.a.
1974	27527	246.1	441.4	n.a.
1975	28452	238.1	452.1	797.0
1976	28631	205.5	400.8	780.5
1977	28273	204.9	401.7	780.0
1978	30477	216.7	521.8	856.3
1979	33212	220.7	643.5	1062.4
1980	32056	270.7	769.1	1205.4
1981	32502	296.8	1020.5	1260.9
1982	35450	359.8	1181.7	1350.8
1983	38728	463.7	1055.0	1402.1
1984	40731	625.8	1191.0	1540.6
1985	37911	414.7	1578.4	1760.7

Source: Statistics China. **Statistics Yearbook of China**, 1984-1986.

Notes: 1. Meat includes pork, beef and mutton.
2. n.a.- not available.

due to the low base, that is, the low level of grain output in 1952. Similar results were found for other major agricultural products. The annual increase in cotton production was 88.8 thousand tons on average from 1952 to 1978, 34.5 thousand tons from 1952 to 1978, and 282.9 thousand tons from 1978 to 1985. The annual increase in edible oil crop production was 41 thousand tons from 1952 to 1978, 1509.4 thousand tons from 1978 to 1985, and 362.2 thousand tons on average from 1952 to 1985. The annual increase of meat production was 207.1 thousand tons from 1952 to 1978, 1292 thousand tons from 1978 to 1985, and 444.4 thousand tons on average from 1952 to 1985. The rapid increase in major products for the period from 1978 to 1985 indicates the great success of the economic reform in the rural China.

However, the development of Chinese agriculture was heavily involved in politics, to a greater extent than in many other countries. As Perkins and Yusuf (1984, p.73.) Stated: "***What sets China apart from other developing countries is not that it has increased the use of chemical fertilizer, but how much it has relied on organizational reform to achieve rural development.***"

2.1.1 Land Reform

Before the People's Republic of China was founded in 1949, "***landlords and rich peasants, less than 10 per cent of the rural population, owned more than 70 per cent of the arable land. However, the poor and middle-class peasants, 90 per cent of the rural population , owned less than 30 per cent of the arable land. And most of farming-power animals (horses, buffaloes, etc.), farming tools and machinery, transportation equipments, irrigation facilities and other means of agricultural production were owned by landlords and rich peasants***"[1]. Although landlords owned much land, they did not cultivate it, but rented it out to landless and land-poor peasants. The majority of these who cultivated land were poor and middle-class peasants. Peasants paid land rental to

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1 Agricultural Division, Statistics China. **The Great Achievements of Chinese Agriculture, 1949-1984**, 1984, pp.1.

landlords, which the Communist Party of China considered to be the economic exploitation of peasants. The revolution led by the Party was directed against the old social system and "the economic exploitation". Land reform---dividing the land seized by landlords and rich peasants among peasants---was inevitable after the Party came to power. The poor peasants and farm laborers received land certificates from the People's Government. The political nature of the land reform is reflected in a summary of the great success of the land reform by Luo Hanxian (1985, p.45.), a Chinese economist:

> "*(1) The broad masses of peasants liberated themselves from the feudal system of land ownership.*
>
> *(2) Another result of the land reform was the expansion of the rural market. As the purchasing power of the peasants rose, sales of all types of daily necessities increased markedly.*
>
> *(3) Political result. As the broad masses of peasants liquidated the feudal system of land ownership, they also toppled the local despots and lawless landlords and became the masters of their own destinies.*"

Compared with Taiwan, the land reform in mainland China was the result of class-struggle and was done through mandatory means, while the land reform in Taiwan was done giving landlords financial compensation.

2.1.2 Collectivization of Agriculture

After the land reform, the economy of agriculture was expanding because of the incentives to farmers since they were working on their own land (Luo Hanxian, 1985). However, farmers lacked means of production and farms were small in term of land, labor and capital.

An individual farm could not withstand disasters, whether they were natural or man-made. Most peasants still suffered from poverty. There was also a difference in the rate of progress achieved by peasants. Some peasants got rich faster than others and a few peasants actually got poorer than before. Large disparities existed among peasants in term of ownership of land and means of production. Some poor peasants had to sell their land in order to repay usurious loans. To avoid the reappearance of "the economic exploitation", the Communist Party called on peasants to form mutual aid teams and cooperatives to take the path of prosperity for all.

Another fundamental reason for the collectivization of agriculture was, as Luo Hanxian (1985) stated: "***the fact that China had embarked on the construction of a planned socialist economy in 1953. ..... It was obvious that socialist industry[2] could not carry on large-scale planned production on the basis of a scattered, unplanned small peasant economy.***" Obviously, the political ideology from Marxism of the Communist Party of China could not allow the existence of private economy in China at the time. Thus the reason for the collectivization of agriculture was not economic but political. Political ideology could not allow the existence of what was viewed as "the economic exploitation", which exists in the private economy. Regarding the economic disparity among people, the Party would pool all people together and let them "eat from the same bowl"[3] rather than taxing the rich and subsidizing the poor, which has been used in many western countries.

The poor, the majority of population in the rural China, whom the Party was trying to save, stood with the Party which served their interests, both political and economic. This made the collectivization of agriculture possible.

---

2 Industry refers to the secondary sector of economy by classification of economics in western countries.

3 "Eating from the same bowl", the popular term in China, refers to the socialist system of economy in China from 1950's to 1970's.

The collectivization of agriculture took three forms successively. The first form was of mutual aid through labor, and was called the mutual aid team. The second was called the elementary agricultural producers' cooperatives, in which land was pooled in shares and the cooperatives were managed by all members. The third was called the advanced agricultural producers' cooperatives in which the collective ownership of land replaced the private ownership of land which existed in the first two forms. Table 2-2 shows the annual change of the collectivization of agriculture for the period from 1950 to 1958.

2.1.3 The People's Commune System

The Marxist political ideology of the Party put one step toward the collectivization of agriculture in the formation of the people's commune system based on agricultural producers' cooperatives in 1958. The system was defined as "three level ownership by the commune, the production brigade and the production team, with the production team as the basic accounting unit". The idea was for ownership to transfer from the production team to the production brigade and then to the people's commune, thus transforming ownership from the small collective to the large collective, then to the whole people, and ultimately from socialism to communism. After more than twenty years of experience, it was recognized that the idea was essentially theoretical and political.

2.1.4 Evaluation of the Collectivization of Agriculture

Although we can see that the collectivization of Chinese agriculture was driven by Marxist political ideology, it also was required by the nature of the centrally-planned economy of China. A third reason for collectivization could be the economic condition of agriculture after the land reform, with most of the individual small farms in terms of land, labor and capital having

Table 2-2. The Percentage of Farming Households in the Collectives of the Total Farming Households, 1950-1958

year	mutual aid teams (1)	agricultural producers' cooperatives[1] (2)	people's communes (3)	total of (1), (2), (3)
1950	10.7			10.7
1951	19.2			19.2
1952	39.9	0.1		40.0
1953	39.3	0.2		39.5
1954	58.3	2.0		60.3
1955	50.7	14.2		64.9
1956	0.9	96.3		97.2
1957		97.5		97.5
1958			99.1	99.1

Source: Agricultural Division, Statistics China. **The Great Achievements of Chinese Agriculture, 1949-1984,** 1984.

Notes: 1. Both elementary and advanced cooperatives are included.
2. Empty cells are not applicable.

insufficient ability to overcome natural disasters, etc. The collectivization of agriculture might also yield benefits from economies of scale and make possible the mechanization of agriculture and large-scale investment, such as in irrigation facilities.

Experience showed that the collectivization of agriculture did promote the development of Chinese agriculture and benefit the national economy in the 1950's and the early 1960's when political ideology was strong for both Chinese officials and peasants (Luo Hanxian, 1985). But the gradual reduction of the impact of the political ideology and understanding of economic and material satisfaction of human being after the "Cultural Revolution" made the system of the people's commune less and less workable over time. The nature of human beings involves selfishness which was not supposed to exist for the Party and its followers under the political ideology, but was shown strongly when the influence of the ideology was gone. The inefficient nature of the centrally-planned economy and its unsuccessful economic experience made economic reform in China inevitable rather than voluntary.

Chinese economists and officials in the late 1970's and 1980's tended to criticize the people's commune system but not other forms of the collectives. The people's commune system was replaced by the responsibility system which was formed as Chinese agriculture was decentralized from 1979. Actually the advanced agricultural producers' cooperatives were not all that different in nature, but only in degree, from the system of the people's commune. The commune system was formalized throughout China and was more advanced than other forms of collectives according to the political standards of the Party at that time. The advanced agricultural producers' cooperatives and the system of the people's communes were both based on the collective ownership of land and the principle of pooling peasants together. The only essential difference is the scale of their operation.

It seems obvious that the collectivization of agriculture driven by the political ideology worked when belief in the ideology existed and did not work when belief in the ideology was gone. The ideology might change the human being temporarily, but the nature of human being seems likely to be finally evident and dominates development.

2.1.5 Chinese Agriculture after the Year of 1978

The people's commune system was carried on until the late 1970's when its inefficiency of operation had been fully recognized through the experience of more than twenty years. Political ideology began breaking down in China about 1973 after the cultural revolution[4]. The full experience of the political movements and the strong political goal of agricultural policy resulted in the slow development of Chinese agriculture. Many peasants were still in poverty and quite a few were even starving. "Eating from the same bowl" had become the source of lack of incentives and inefficient operation of agriculture rather than the path of prosperity for all. This made the Party look for alternatives to save peasants and develop agriculture and the national economy.

The economic reform was started in rural China in 1979. The reform could be summarized by its following aspects (An Xi-ji, 1985):

(a) Responsibility system. To create incentives for farmers, "eating from the same bowl" was replaced by the responsibility system. Farmers were fully responsible for the profit and losses of their operation. The collective ownership of land was not changed. The responsibility system represents the decentralization of agriculture in terms of production and management, but not ownership of land.

(b) Readjusting rural economic structure. Grain production was overemphasized and regional

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4 The officially announced time of the cultural revolution is from 1966 to 1976, although the revolution was largely over in 1969 when its mission was accomplished.

grain sufficiency in grain production was sought before 1979. The policy favorable only to grain production resulted in the slow development of production of cash crops, forestry, animal husbandry, rural manufacturing industry and other sideline production. The reform was directed to diversify agriculture and develop these industries to their possible potential.

(c) Reforming the planning of production. Production quotas used to be assigned from the very top level to the production teams through many levels in between. The quota system was abolished in 1985. Farmers were encouraged to develop farming patterns according to their local conditions.

(d) Reforming the marketing system of agricultural products. Government used to be the only buyer and seller of many agricultural products, such as grain, cotton, and oil seeds. The government used to set prices of agricultural products and control marketing channels. Control over prices and marketing channels was released over time. Government purchase was done through contracts with farmers instead of through mandatory quotas.

2.2 Agricultural Policy of China, 1949-1985

The development of Chinese agricultural policy over the past four decades could be divided into two periods, the political-oriented period, from 1949 to 1978, and the economic-oriented period, from 1979 to 1985.

2.2.1 The Political-oriented Period, 1949-1978

The success of the revolution led by the Party relied heavily on political ideology from Marxism. Continuation of the political ideology after the founding of new China was inevitable for the Party and its followers. Following the path of socialism, which would lead to communism, had to be ensured in every step of the Party and every movement of the Chinese people. Today,

it is still one of "the four major principles"[5] which the Party pursues in politics. "Follow what Mao says" and "do what the Party asks you to do" was the political education that peasants and other Chinese received from the Party. Both agricultural policy-makers and farmers had strong political goals in mind and did not have much economic consideration of their decisions since is was believed that political benefit was far more important than economic benefit.

Based on political ideology, the centrally-planned economy was developed in China. Control over the national economy and agriculture was shown in all dimensions. Prices and areas of crops planted were controlled by government. Grain production was dominant in Chinese agriculture because of Mao's policy, "grain is the king,.....", for the development of agriculture. Sideline production was limited as capitalist. Other rural industries, such as animal husbandry and fishery, were not well developed. The political goals of agricultural policy resulted in the slow development of Chinese agriculture for the period from 1949 to 1978.

Eventually, the long and unsuccessful experience of economic development and the unchanged life of poor living conditions for most peasants resulted in doubts as to the path of socialism which the Chinese were following. The advantage of socialism over other systems in economic development were not shown. From 1973 to 1974, some communist leaders and peasants started recognizing the importance of economic development and the impossibility of substituting material satisfaction of human beings for spirit satisfaction from the class struggle[6]. In 1974, Deng Xiaoping came to power as the first vice-premier of the State Council of China. The economic goal of his policy was represented by his famous saying: "The cat is

---

5 The four major principles are: (1)following the path of socialism; (2)Marxism-Leninism-Mao Zedong Thought; (3)leadership of the Party; and (4)the dictatorship of people's democracy.

6 The class struggle was pursued by the Party and its followers. It was popular in China for the period of 1950's to 1970's, especially in rural China. It was costly in term of labor and other resources but not productive.

good if she can catch mouse[7], no matter if she is white or black". But economic prosperity resulting from the policy only lasted for one year because of the strong opposition of "the Gang of Four" against Deng. Deng Xiaoping stepped down in 1975 and the Chinese wandered on the socialist path for another three years.

2.2.2 The Economic-oriented Period, 1979-1985

Deng Xiaoping came to power again in the beginning of 1978. Economic-oriented policy started with the economic reform in rural China in 1979. As mentioned earlier in this chapter, agriculture was decentralized through the responsibility system and the market mechanism was introduced through reforms in the pricing and marketing system for agricultural products. The creation of incentives and the gradual release of government control over agriculture resulted in great achievements for Chinese agriculture for the period from 1979 to 1985. However, the economic development improved the level of living of most peasants but did not meet the political goals of some Chinese. Developing capitalism in China caused worry for some Chinese, especially some senior statesmen and older members of the Party. Debate over the nature of the path, socialist or capitalist, the Chinese were taking was the most controversial issue since 1979. The stepping down of Hu Yaobang, general secretary of the Party, indicated the existence of strong power against developing capitalism in China. Despite the debates among politicians and economists, peasants became more and more economically aware in their life and more economically oriented in their decision-making.

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7 Most cats raised in China are supposed to be for catching mice rather than as pets.

III A Review of Relevant Economic Theory and Literature

An important contribution to theory of supply response for farm products was in 1938 when Ezekiel published the classic paper, "The Cobweb Theorem". Two other major landmarks in the theory of supply response are Nerlove's (1958) partial adjustment model and Muth's (1961) hypothesis of rational expectations. The literature has abounded with empirical studies analyzing the responses of farmers to the relevant prices and other economic factors since the 1930's.

3.1 The History of Development of Relevant Theories

3.1.1 "The Cobweb Theorem"

In his 1964 article, Waugh reviewed the process of development of the cobweb theorem. As early as 1917, Moore had demonstrated the cobweb phenomena in crop production without using the word "cobweb". And in 1928, Hanau found the cobweb phenomena in hog production. In 1930, three economists, Umberto Ricci, Jan Tinbergen and Henry Schultz, published cobweb diagrams like the one discussed by Ezekiel independently of one another. The three economists talked about the cobweb theorem rather briefly in their papers, but each did discuss its main features. Ezekiel's 1938 paper was the first to discuss the cobweb model in detail.

Waugh's paper also generalized the simple cobweb model into converging, continuous and diverging models. Effects of government programs, such as price support, were considered and multidimensional cobwebs to describe simultaneous adjustments in prices and outputs of a number of commodities were discussed.

In the simple cobweb model, it is assumed that the agricultural production decisions in period t are based on the prevailing price at that time P_t. As the output will not be available for the sale until the next period $(t+1)$, P_t will determine Q_{t+1}. However, it seems that the empirical studies based on the cobweb theorem do not support this simple form of the theorem.

The mathematical version of the cobweb model is summarized in Chiang (1984, pp.561-64). The model consists of a demand and supply relation:

(3.1) $Q_t^d = Q_t^s$

(3.2) $Q_t^d = d_0 - d_1 P_t + u_t^d$

(3.3) $Q_t^s = s_0 - s_1 P_{t-1} + u_t^s$

where: Q_t^d = Quantity demanded at time t,

Q_t^s = Quantity supplied at time t,

d_i = Demand coefficients,

s_i = Supply coefficients.

3.1.2 Nerlove's Partial Adjustment Model

The empirical findings of a week linkage between price in a previous period and output, seems unlikely to be consistent with the real world phenomenon of cobweb cycles in the agricultural market. And also Nerlove (1958) found that the numerical estimates seemed to be contradicted by experience under the support programs in the United States. Nerlove (1958) suggested: "***Farmers react, not to last year's price, but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was.***" In the formation of farmers' expectations, Nerlove assumed further "***each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period.***" Applying the model based on this hypothesis, the empirical estimates by Nerlove were substantially different from those by previous researchers. Estimates of the elasticities of area with respect to expected price and R^2 (the square of the multiple correlation coefficient) were

much higher than previous estimates. The results, as Nerlove argued, were more "***in line with our experience with price supports and more compatible with the results of studies on production functions and farmers' reactions to the allotment program***."

The development of Nerlove's partial adjustment model was a landmark in modeling the supply response of agricultural products by farmers. In their survey article, Tomek and Robinson (1977) summarized the significant contribution of the work of Nerlove to time-series supply analysis: "***His distributed lag models (discussed earlier), in principle, make it possible to obtain separate estimates of short-run and long-run elasticities. These models, which have a rather elegant simplicity, frequently produce higher R2 values than alternative models and in some cases appear to reduce or eliminate the problem of serial correlation in the residuals***". One of the well-known studies based on the Nerlove model is the study by Raj Krishna in 1963. In this paper, Krishna presented some estimates of the "short-run" and "long-run" elasticities of supply (area) of agricultural commodities derived from time series data for the Punjab, India. Other studies have tried to incorporate government programs into the model. For example, Lee and Helmberger (1985) showed the different nature of supply response under farm programs versus competitive markets. Their research results for the United States concluded that "***corn area response is shown to be more own-price-responsive in years of area control programs than in other years due to the land use alternative provided by these programs and program entry (or exit) of farmers. Soybean area response appears less own-price-responsive and more cross-price-responsive under feed grain programs than in a free market***."

The hypothesis of Nerlove partial adjustment can be expressed mathematically as follows (Nerlove, 1958):

(3.4) $$P_t^* - P_{t-1}^* = \beta (P_{t-1} - P_{t-1}^*)$$

$$0 < \beta \leq 1$$

where: P_t^* = expected price in time t;

P_{t-1}^* = expected price in time (t-1);

P_{t-1} = actual price in time t; and

β = the coefficient of adjustment.

Note that the Nerlove partial adjustment model is different from the cobweb model unless β is equal to one.

Equation (3.4) can be expressed mathematically as the following equation:

(3.5) $$P_t^* = \beta P_{t-1} + (1-\beta)\beta P_{t-2} + (1-\beta)^2 \beta P_{t-3} + \ldots$$

This shows the hypothesis that "***Farmers revise the price they expect in proportion to the error they have made in prediction, is equivalent to one in which expected price is represented as a weighted moving average of past prices where the weights are functions solely of the coefficient of expectation.***"(Nerlove, 1958). This indicates that the expectations model assumes price expectations are formed in a particular way (a geometrically diminishing lag). This is obviously unrealistic since farmers do not base their plan solely on past prices (Tomek and Robinson, 1977).

Let x_t be area this year, P^*_t be the price expected this year, and u be a random residual term. Then we can write the Nerlove's area response function as follows:

(3.6) $$x_t = \alpha_0 + \alpha_1 P_t^* + u_t$$

We cannot estimate equation (3.6) directly since we cannot observe P^*_t. Nerlove argued that equation (3.6) can be rewritten to relate any expected price, P^*_t, as a linear function of area x_t. Thus, last year's expected price, P^*_{t-1}, can be represented by last year's area, x_{t-1}. By relating P^*_{t-1} to x_{t-1} in equation (3.4), P^*_t, the expected price this year is expressed as a function

of last year's actual price and last year's area. If this expression is substituted for expected price into the area response function, equation (3.6), a new relation between the area this year and last year's actual price and last year's area is derived, it is:

(3.7) $$x_t = \pi_0 + \pi_1 P_{t-1} + \pi_2 x_{t-1} + \upsilon_t ,$$

where: $\pi_0 = \alpha_0 \beta$

$\pi_1 = \alpha_1 \beta$

$\pi_2 = 1 - \beta$

where v_t is a random residual different from u_t.

The Nerlove-type models used in the empirical study contain the lagged dependent variable as an explanatory variable. As is usual in supply equations for crops, area planted is the dependent variable. The coefficient of the lagged variable may reflect the influence of other variables which are associated with trends in the dependent variables, such as technology change. Such coefficients may measure more than an adjustment or expectation process (Tomek and Robinson, 1977).

3.1.3 Rational Expectations

In his article in 1961, "Rational Expectations and the Theory of Price Movements", John Muth argued that the hypothesis of rational expectations "***assesses that economic agents do not waste information. ..... Expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory.***" Following this hypothesis, it is assumed that farmers make production and supply decisions based on all the information available, including past price experience, and based on the structure of the economic system in which farmers operate.

However, some economists argue that economic agents' perceptions might be different from what is assumed in rational expectations because learning the true underlying structure of economy is not easy and this may become even more difficult when there is continual structural change (DeCario, Friedman, 1979). But some recent theoretical research in this areas has suggested that the economic agents' learning process, in the long run, will converge to a rational expectation equilibrium (Sheffrin, 1983).

Empirically, the existence of cobweb phenomena in the agricultural market seems inconsistent with the hypothesis of rational expectations. The world facing farmers looks different from the one facing economic theorists. Rational expectations assume that farmers do not waste information and that their expectations are essentially predictions of the relevant economic theory. But a full set of information is rarely available to many farmers, especially to farmers in the third world. It is more likely that farmers make their decisions based on their subjective perceptions which are often subject to certain biases rather than on the relevant economic theory which is shared mostly by economists. Even when information is available, there are still some questions about the precision of information and interpretation of information by farmers. And learning the true structure underlying the agricultural market is even harder because of the high risks and uncertainty involved in production and marketing of agricultural products. Some factors, such as weather, are still beyond the control of farmers and are not easily predicted for the long-run with today's technology. The notion that farmers are rational decision makers is still debatable.

3.2 Classification of Studies of Supply Response of Agricultural Commodities[8]

Tomek and Robinson (1977) divided the literature related to supply analysis for agricultural products into three main categories: (1) studies of the supply of individual commodities based on time-series data, (2) studies based on budgeting techniques or linear programming models using typical farms or regions as units of analysis, (3) studies of aggregate supply including both the development of theoretical concepts and the estimation of the response of total farm output to changes in product and factor prices. Another classification was given by Krishna (1967), in which responsiveness of market supply was viewed as another category. In most previous studies of price responsiveness, the price elasticity of area planted is used as a proxy for intended output. This is a good approximation of the price elasticity of output on the assumptions that when the area in a crop is varied, other inputs can be varied at an equal pace, and over the relevant ranges of the production functions returns to scale are not diminishing (Krishna, 1967).

3.2.1 Single Crop Response

The most popular empirical study on supply response is the study on the supply response of individual commodities based on time-series data using single-equation models and ordinary least squares estimation. As a pioneer researcher on supply response for developing countries, Krishna (1967) divided the short-run price elasticity of area into low-response (with an elasticity range of 0-0.1), medium-response (0.1-0.4) and high-response (0.4-0.7) crops. His study on data for poor nations suggests that the subsistence crops of wheat, barley, maize, rice, millets and gram fall in the first group. He found that the area of these crops either did not respond

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8 This section owes a lot to the work of Raj Krishna, especially his paper: "Agricultural Price Policy and Economic Development", *Agricultural Development and Economic Growth*, 1967, pp.497-541.

or responded little to relative price variations. He suggested that the low response of subsistence grain crops might be attributed to two factors: the nature of subsistence grains themselves and the extent of isolation of the rural areas where the subsistence grains were planted. In an isolated area, subsistence grains are planted to feed local people without regard to the relative price changes, especially if the hunger problem is not solved in these areas. Krishna's research results (1963, 1965, 1967, etc.) for the less developed countries (Pakistan, India, Indonesia, etc.) in the first half of the century suggested this type of situation. For open areas where trade with the outside world is possible, the responsiveness of subsistence grains is expected to be higher. For example, for studies on wheat supply response in the same general period (from 1900 to the 1960's), the estimates of short-run elasticities of most studies for the developed countries (France, United Kingdom, Canada and the United States) tended to be higher than these for the less developed regions (India, Pakistan)[9]. In contrast, cash crops generally are fairly responsive to price changes, a factor which can be explained by the purpose of planting cash crops. Cash crops are planted to earn money, therefore, the areas sown of these crops are expected to be sensitive to their market prices.

3.2.2 Responsiveness of Market Supply

If there is a lack of data on market sales for food crops, market supply functions can not be estimated directly. Krishna (1967) suggested some indirect methods of estimating supply functions, specifically through the relationship between the market supply and output from cross-section data. The relationship (other linear and nonlinear relationships may exist) can be shown as

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9 This observation is made based on the paper of Askari and Cummings: "Estimating Agricultural Supply Response with the Nerlove Model: A Survey", *International Economic Review* 18, 257-92.

(3.8) $e = b E_{mq}$

where: e = price elasticity of market supply;
b = price elasticity of output; and
E_{mq} = output elasticity of market supply.

Research by Krishna (1965) indicated that the output elasticity of market supply of wheat was between 1.04 and 1.6 in many villages in India. Krishna (1967) suggests that since the output elasticity of market supply is usually found to be greater than unity, we can conclude that the price elasticity of market supply is normally greater than the price elasticity of output. That is, if output increases in response to any price increase, sales may be expected to increase more than proportionately to output, but if output falls for any reason, market supply will fall more than proportionately.

3.2.3 Responsiveness of Aggregate Output

Knowledge of the response of aggregate output to relative prices is necessary for the formation of an appropriate price policy for agricultural development. Traditionally, this response was believed to be low because of the limitations of the opportunity use of land in traditional agriculture (Krishna, 1967). Changes in relative prices among agricultural products cause farmers to switch their resources from one product to another, but total agricultural output may not be able to increase much in response to a change in their terms of trade.

However, the responsiveness of aggregate agricultural output to price changes is today believed to be higher than formerly. Krishna (1967) listed the following factors which might influence this. First, transportation conditions for agricultural commodities in different regions may have an effect. The situation of an isolated agricultural sector with difficult transportation and communications with the outside world involves no trade; there would, therefore, be little responsiveness of output to changes in the terms of trade. Responsiveness is meaningful in an

open economy where there are at least minimum transportation facilities available and some commercialization of agriculture. Thus, responsiveness can differ from region to region simply because of differences in transport facilities or opportunities. Second, population growth and a situation of increasing demand for commercial crops may both encourage response to price changes of aggregate output. Third, where surplus labor and land are available, farmers will use these to expand exportable output without reducing their subsistence levels, after the minimum necessary infrastructure has been created. In this situation, agricultural output should be price-responsive over a considerable range. Fourth, changes in the cropping pattern alone may also increase agricultural output when the terms of trade changes. Fifth, more intensive application of labor and capital to irrigation and land improvement, more careful husbandry and greater use of farm compost, may increase agricultural output, if prices are favorable. Sixth, when a government is doing its best to restructure agriculture institutionally and to expand the availability of knowledge and inputs, it may find that output remains stagnant until these measures are supplemented by a positive agricultural policy.

IV The Models, Data, and Estimation

This chapter consists of three sections. Models used in this study are specified and justifications of policy variables used in the context of Chinese agriculture are provided in section one. The data analyzed in the study and their sources are discussed in section two. Section three outlines the estimation procedures.

4.1 Specifications of Models

Nerlove's partial adjustment model is employed in this study. Askari and Cummings (1977) summarized the Nerlove model with the following three equations:

(4.1) $$x_t^D = \alpha_0 + \alpha_1 P_t^* + \alpha_2 Z_t + u_t$$

(4.2) $$P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*)$$

(4.3) $$x_t = x_{t-1} + \gamma(x_t^D - x_{t-1})$$

where: x_t = actual area under cultivation at time t;
x_t^D = area desired to be under cultivation at time t;
P_{t-1} = actual price at time (t-1); and
P_t^* = expected price at time t.

There are important differences in the way that models have been employed in empirical studies. Askari and Cummings (1977) summarized the differences by three categories: "***First are modifications affecting the variables used by Nerlove; second are inclusions of factors of particular interest in the situations under investigation, corresponding to the variable Z in equation (4.1); finally come attempts to represent quantitatively situations not considered by Nerlove-primarily perennial and/or slow-maturing (i.e., more than one crop-season) crops, and livestock.***"

The Nerlove-type models used for estimations of area response equations of single cash crops in this study are:

Model 1: $AC_t^i = \alpha_0 + \alpha_1 AC_{t-1}^i + \alpha_2 PR_{t-1}^{ij} + \alpha_3 PAC_t + u_t$

Model 2: $AC_t^i = \alpha_0 + \alpha_1 AC_{t-1}^i + \alpha_2 PC_{t-1}^i + \alpha_3 PC_{t-1}^j + \alpha_4 PAC_t + u_t$

where:
AC_t^i = area of crop i planted at time t;
AC_{t-1}^i = area of crop i planted at time t-1;
PR_{t-1}^{ij} = price ratio of crop i over crop j at time t-1;
PC_{t-1}^i = price of crop i at time t-1;
PC_{t-1}^j = price of crop j, a competitive cash crop to crop i at time t-1;
PAC_t = the percentage of total area of cash crops planted to crops; and
α_i = coefficients, i = 1, 2, 3, ...

Analysts have been encouraged to employ price ratios rather than producers' prices in such Nerlove-type models to avoid estimation problems. There is a tendency for economic variables to move together over time (Koutsoyiannis, 1986). Producers' prices for cash crops usually tend to move in similar fashion. There are more possibilities of problems like multicollinearity in estimation due to correlation among explanatory variables if producers' prices are used instead of price ratios. Price ratios measure relative changes in prices in real terms. The degrees of freedom in the estimation also increases when price ratios are used instead of producers' prices.

PAC_t is taken to be the policy variable representing the effect of control of government over agriculture. Chinese agriculture has been under the control of government since the Communist Party took over China in 1949. With economic reform since the late 1970's, some controls over agriculture have been released. Achieving a self-sufficient supply of grain has been one of the goals of the agricultural policy of the government since the problem of shortage of domestic supply of grain has remained until recent years. The problem of shortage is shown by ration coupons issued by the government from the 1950's to the early 1980's. Priority was

placed on grain production to meet the domestic demand for food. Another important factor, probably the most important, for the priority of grain production is Mao's agricultural policy: "Grain is the king, ...". Two other reasons for the priority given grain production, as was mentioned in Chapter Two, are the limited grain storage facilities and scarce foreign currency. Thus the government has to rely heavily on the current supply to meet the current demand for agricultural products. A good grain harvest in any year tends to reduce the shortage problem and result in less land allocated to grain crops by the government in the next year. This is because that the existence of shortages of other commodities for the period, such as edible oil and sugar[10], requires allocation of more arable land for planting other crops. On the one hand, the Chinese government has to ensure the domestic supply of grain to meet the domestic demand for food, leading to the priority for grain production in agricultural policy. On the other hand, the government has to balance the allocation of arable land among crops to meet other needs of daily living, especially when shortage problems of grain are not urgent.

Estimates of the coefficient on PAC_t are expected to show the effect of control of government over the allocation of arable land among crops. Estimates of coefficients of own and cross prices (or price ratios) will show the extent of farmers' response to the changes of relevant prices (or price ratios) even though the allocation of arable land was under control of government.

Based on the general models discussed above, specification of models used for estimations of response equations of each single cash crop also involves selection of appropriate competitive crops. Since the competition for land occurs only for cash crops planted in the same area, competitive cash crops are selected according to the distribution of area of cash

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10 The shortage of these and other commodities is shown by the ration coupons issued by the government.

crops planted, which is shown by Table 4-1. The pattern of cash crops planted is assumed not to change much over time due to the requirements of crops for particular climates. It is assumed that as the movements of relevant prices are favorable, changes in area of large cash crops planted have more impact on the area of small cash crops planted rather than vice versa, since the same percentage in area planted takes more land for large cash crops than for small cash crops. For example, cotton is considered to be a large cash crop, based on area planted. Hemp and jute, and sugarcane are selected as competitive crops for cotton since they are planted in similar regions, i.e. regions of the east, central and south. Tobacco is assumed not to be a competing crop to cotton since it is grown over much of the country and a relatively small area is planted in regions where cotton is grown. All other four cash crops considered are selected as competitive cash crops for tobacco. Cotton is selected as the competitive cash crop for hemp and jute due to: (1) the similar regional distribution of planting, (2) their relationship as substitutes in usage to each other, and (3) the dominant nature of cotton as a cash crop in term of area planted. Cotton is selected as the competitive cash crop for sugarcane due to: (1) the similar regional distribution of planting, and (2) the dominant nature of cotton as a cash crop in term of planted area. Tobacco is selected as the competitive cash crop for sugar beet due to its similar pattern of planting in the regions of the northeast and northwest.

4.2 The Data

The five individual cash crops under study are cotton, hemp and jute[11], sugarcane, beet and tobacco. Annual national level data from 1952 to 1971 are used for the empirical analysis.

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11 As hemp and jute are pooled together in the data sources, so are they in the empirical study.

Table 4-1. The Distribution of area of Cash Crops Planted (ten thousand mu[1]), 1985

Regions	Cotton	Hemp and Jute	Sugarcane	Sugar beet	Tobacco
North					
Beijing	7.6			1.5	0.2
Tianjin	43.1	3.4			0.4
Hebei	1275.4	25.0		17.3	17.2
Shanxi	181.7			16.2	3.0
Northeast					
Neimonggol				150.5	5.4
Liaoning	58.7	0.7		20.7	27.9
Jilin				103.9	31.6
Heilongjiang				438.1	75.7
East					
Shanghai	106.6				
Jiangsu	888.4	37.2	6.2	6.6	6.5
Zhejiang	139.6	57.2	26.9		4.8
Anhui	352.6	346.2	3.5		62.6
Fujian		10.4	109.9		46.0
Jiangxi	99.5	24.5	56.5		10.7
Shandong	1754.6	120.5		7.0	174.5
Central					
Henan	1221.5	336.9	6.5	1.0	376.4
Hubei	697.5	141.3	11.8		90.3
Hunan	152.7	84.7	37.7		147.0
Guangdong		58.7	640.7		55.6
South					
Guangxi	2.5	119.8	332.1		26.3
Sichuan	189.7	117.6	82.6	1.7	147.6
Guizhou	3.7	2.3	6.7	0.4	268.5
Yunnan	4.2	0.3			320.1
Xizang			125.6	0.4	
Northwest					
Shaanxi	141.9	0.6	0.5	6.0	63.0
Gansu	8.7			28.0	6.9
Qinghai				0.2	0.1
Ningxia				17.9	
Xinjiang	380.3			23.3	0.8
Total	7710.5	1487.3	1447.2	840.7	1969.1

Source: Statistics China. **Statistics Yearbook of China**, 1986.

Notes: 1. One mu is equal to 0.0667 hectare, that is, one hectare is equal to 15 mus.

Variables include area of crops planted (AC_t), producer's prices (PC) and price ratios (PR)), and the current percentage of the area of cash crops relative to the total area of crops planted (PAC_t). PAC_t is the policy variable, which was discussed in detail in an earlier section. The data are from the Statistics Yearbook of China(1984-1986) and the further publication by the Statistics China, The Great Achievements of Chinese Agriculture, 1949-1984.

4.3 The Estimating Procedures

The ordinary least squares method is used to estimate the single supply equation models. Due to the auto-regressive nature of Nerlove model, the Durbin H test is used to test for auto-correlation. "***Durbin-Watson d statistic may not be used to detect (first-order) serial correlation in auto-regressive model, because the computed d value in such models generally tends toward 2, which is the value of d expected in a truly random sequence.***"(Gujarati, 1988, pp.525-26). When Durbin H test can not be computed, Durbin-Waston d values are used as references. In the case that the existence of auto-correlation is not clear by these tests, correction of potential auto-correlation is applied through a maximum likelihood procedure to see whether the results are improved in term of the R-square and significance of estimates of coefficients. The Breuch-Pagan test is used to test the homascedasticity of the model. White's (1980) heteroscedastic-consistent covariance matrix estimation is used to correct the estimates if heteroscedasticity exists with the models. The econometrics computer program Shazam Version 5.1 is employed to run the estimations.

The period of 1952 to 1971 is selected for the estimations based on the nature of the economy, as was discussed in Chapter Two. Linear, semi-log and log forms of hypothesized model are tested. The results of the models best fitting the data as indicated R-square coefficients are given in the following chapter.

V Results and Interpretation

In this chapter, the econometric estimates of models using ordinary least squares are summarized and interpreted. Major indicators of models are presented, including estimated coefficients and their associated t-ratios, R-square, short-run and long-run elasticities, and results of tests on homoscedasticity and autocorrelation.

5.1 Cotton

Table 5-1 shows the OLS estimates for the cotton area response model that includes PAC_t as policy variable for the period. The results might be unexpected to most Chinese economists since they might expect no response of farmers to the economic factors (here represented by the price ratio) due to the tight control of government over agriculture during the period. Actually the estimates of both short-run and long-run elasticities are quite high. This suggests that Chinese farm units had a degree of freedom to respond to relative prices in their decision making on areas of cotton planted, even under the centrally-planned economy of China.

The effect of control of government over agriculture during the period is shown by the estimated coefficient of the policy variable, PAC_t. The size of the coefficient and its associated t-ratio suggests the importance of government controls over agriculture at macro-level[12]. The positive sign on PAC_t indicates that the higher the percentage of arable land available for cash crops, more area of cotton would be planted, all other things being equal. The policy variable, PAC_t, was tightly controlled by the government to ensure the priority of grain production.

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12 This observation is confirmed by the estimates of area response equations of other individual cash crops in the following section.

Table 5-1. OLS Estimates of Cotton Area Response Equation (1952-1971)

Variable Name	Estimated Coefficient	Estimated Elasticity of Supply	
		Short-run	Long-run
AC_{t-1} (area of cotton)	0.14073 (2.6641)	0.32732	
$PRCHS_{t-1}$ (price ratio)	3.52130 (6.0858)		0.38093
PAC_t (percentage of total crop area planted to cash crops)	868.660 (13.855)		
Constant	-3173.4 (-7.4713)		
R^2 Adjusted	0.9496		
Durbin-Watson	2.7547		
Durbin H	-1.8232		

Notes:

a. t ratios are in parentheses;

b. We could not reject the hypothesis of homoscedasticity from the result of Breusch-Pagan Test; the test statistic is 4.606, which is less than the critical value of Chi-square(11.345) at the 1% level.

c. We could reject the hypothesis of no first-order autocorrelation from the result of Durbin H Test; the test statistic is -1.8232, which is less than the critical value of h(-1.645) at the 5% level.

d. The estimated d value(2.755) of Durbin-Watson Test lies in the indecisive range(d_l=0.742, d_u=1.415), so we can not say whether there is autocorrelation or not at the 1% level.

e. The result showed above is from OLS estimates after the correction of autocorrelation is done by a maximum likelihood procedure.

f. The price ratio variable included in this equation is cotton price divided by the average price for sugarcane, hemp and jute.

However, the allocation of arable land among cash crops (cotton and other cash crops) was much less controlled by the government. The estimates suggest that farmers did take the opportunity to adjust planted areas of cash crops as the relevant prices changed.

The estimate of coefficient of PAC_t represents the effect of control of government over agriculture at macro-level, while the estimates of the price coefficient and the short-run and long-run elasticities indicates the response of farmers to changes of the relevant prices at micro-level. The high R-square and the highly significant estimated coefficients suggest a good fit of the cotton area response equation.

5.2 Tobacco

Table 5-2 shows the estimates of tobacco area response equation for the period of 1952 to 1971. The estimates suggest that farmers responded to the changes of relevant prices in their decision-making on the planted area of tobacco. The short-run and long-run elasticities are 0.63254 and 1.4820 respectively. The estimate of coefficient of the policy variable, PAC_t, indicates the strong impact of government control on the area of tobacco planted.

5.3 Hemp and Jute

Table 5-3 shows the estimates of hemp and jute area response equation for the period of 1952 to 1971. The estimates suggest the significant effect of both economic and policy factors in determining areas of hemp and jute planted. The short-run and long-run elasticities are 0.8185 and 2.5168 respectively.

Table 5-2. OLS Estimates of Tobacco Area Response Equation (1952-1971)

Variable Name	Estimated Coefficient	Estimated Elasticity of Supply	
		Short-run	Long-run
AT_{t-1} (area of tobacco	0.36746 (2.5211)	0.93742	
$PRTPP_{t-1}$ (price ratio)	0.93742 (2.2791)		1.48200
PAC_{t-1} (percentage of total crop area planted to cash crops)	1.41132 (3.6274)		
Constant	-3.9773 (-1.7579)		
R^2 Adjusted	0.6950		
Durbin-Watson	2.4035		
Durbin H	-1.2119		

Notes:

a. t ratios are in parentheses;

b. We could not reject the hypothesis of homoscedasticity from the result of Breusch-Pagan Test; the test statistic is 1.133, which is less than the critical value of Chi-square(11.345) at the 1% level.

c. We could not reject the hypothesis of no autocorrelation from the result of Durbin-Watson Test; the test statistic is 2.404, which is greater than d_u(1.415) and less than 4-d_u (2.585) at the 1% level.

d. We could not reject the hypothesis of no first-order autocorrelation from the result of Durbin H Test; the test statistic is -1.212, which is greater than the critical value of h(-1.645) at the 5% level.

e. The price ratio variable included in this equation is tobacco price divided by the average price of cotton, hemp and jute, sugarcane and sugar beet.

Table 5-3. OLS Estimates of Hemp and Jute Area Response Equation (1952-1971)

Variable Name	Estimated Coefficient	Estimated Elasticity of Supply	
		Short-run	Long-run
AH_{t-1} (area of hemp and jute)	0.18147 (1.5090)	2.06010	
$PRHC_{t-1}$ (price ratio)	2.06010 (2.4038)		2.51683
PAC_{t-1} (percentage of total crop area planted to cash crops)	1.79300 (4.8342)		
Constant	-5.64290 (-2.1424)		
R^2 Adjusted	0.7932		
Durbin-Watson	0.6473		
Durbin H	5.0723		

Notes:

a. t-ratios are in parentheses;

b. We could not reject the hypothesis of homoscedasticity from the result of Breuch-Pagan Test; the test statistic is 1.918, which is less than the critical value of Chi-square(11.345) at the 1% level;

c. The estimated d value(0.647) of Durbin-Watson Test lies in the range of positive autocorrelation(d_l=0.742, d_u=1.415), so we can say there is positive correlation at 1% level;

d. We could reject the hypothesis of no first-order autocorrelation from the result of Durbin H Test; the test statistic is 5.072, which is greater than the critical value of h(1.645) at the 5% level;

e. The result showed above is from OLS estimates after the correction of autocorrelation is done by a maximum likelihood procedure.

f. The price ratio variable included in this equation is the price of hemp and jute divided by cotton price.

5.4 Beet

Table 5-4 shows the estimates of beet area response equation using PAC_t as policy variable for the period of 1952 to 1971. The results suggest that both economic and policy variables are important factors affecting the area of beet planted. The short-run and long-run elasticities are 0.18717 and 22.2327 respectively. The high long-run elasticity indicates that Chinese farmers are very sensitive to the changes of the relevant price ratio. Compared with the other cash crops under the study, the estimate of short-run elasticity for beet is low. This may be due to the dominant nature of beet as a cash crop in terms of area planted in the northeast and northwest of China[13]. Tobacco is another cash crop planted in these regions, but its area planted is much less compared with beet. This apparently limited the response of farmers to favorable price movements since there was little area of other cash crops planted to be reduced. The effect of strong control of government over the beet production was shown by the estimate of coefficient of the policy variable, PAC_t.

5.5 Sugarcane

Table 5-5 shows the estimates of sugarcane area response equation using PAC_t as policy variable for the period of 1952 to 1971. All estimates of coefficients of economic and policy variables are highly significant and have the expected sign except for PC_{t-1}. The positive sign on coefficient of PC_{t-1} may be caused by the correlation among the explanatory variables. The short-run and long-run elasticities are 0.71779 and 1.06377 respectively. The effect of control of government over the sugarcane production is shown by the highly significant estimate of coefficient of the policy variable, PAC_t.

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13 Table 4-1 shows the distribution of acre of cash crops planted in China in 1985.

Table 5-4. OLS Estimates of Sugar beet Area Response Equation (1952-1971)

Variable Name	Estimated Coefficient	Estimated Elasticity of Supply	
		Short-run	Long-run
AB_{t-1} (area of sugar beet)	0.81283 (13.139)	0.77664	
$PRBT_{t-1}$ (price ratio)	4.16130 (2.1449)		4.14938
PAC_{t-1} (percentage of total crop area planted to cash crops)	94.7690 (8.2699)		
Constant	-929.980 (-5.4711)		
R^2 Adjusted	0.8682		
Durbin-Watson	2.5678		
Durbin H	-1.5310		

Notes: a. t-ratios are in parentheses;

b. We could not reject the hypothesis of homoscedasticity from the result of Breuch-Pagan Test; the test statistic is 2.732, which is less than the critical value of Chi-square(11.349) at the 1% level.

c. We could not reject the hypothesis of no autocorrelation from the result of Durbin H Test; the test statistic is -1.531, which is greater than the critical value(-1.645) at the 5% level.

d. The estimated d value(2.568) of Durbin-Watson Test lies in the indecisive range(d_l=0.742, d_u=1.451), so we can not say whether there is positive correlation or not at 1% level;

e. The result showed above is from OLS estimates after the correction of autocorrelation is done by a maximum likelihood procedure, which improved the result, especially the t-ratios.

e. The price ratio variable included in this equation is sugar beet price divided by tobacco price.

Table 5-5. OLS Estimates of Sugarcane Area Response Equation (1952-1971)

Variable Name	Estimated Coefficient	Estimated Elasticity of Supply	
		Short-run	Long-run
AS_{t-1} (area of sugarcane)	0.28221 (2.3954)	0.76356	
PS_{t-1} (price of sugarcane)	0.76356 (2.3799)		1.06377
PAC_{t-1} (percentage of total crop area planted to cash crops)	1.46300 (6.2746)		
PC_{t-1} (price of cotton)	1.53140 (3.1543)		
Constant	-9.29140 (-4.5979)		
R^2 Adjusted	0.9017		
Durbin-Watson	1.8500		
Durbin H	-0.0180		

Notes:
a. t-ratios are in parentheses;

b. We could not reject the hypothesis of homoscedasticity from the result of Breuch-Pagan Test; the test statistic is 4.172, which is less than the critical value of Chi-square(13.277) at the 1% level.

c. We could not reject the hypothesis of no autocorrelation from the result of Durbin-Watson Test; the test statistic is 1.850, which is greater than d_u(1.584) and less than 4-d_u (2.416) at the 1% level.

d. We could not reject the hypothesis of no first-order autocorrelation from the result of Durbin H Test; the test statistic is -0.018, which is greater than the critical value of h(-1.645) at the 5% level.

VI Summary and Conclusions

This chapter provides a summary of the results presented in the last chapter and conclusions which can be drawn from the results. Problems of the study are discussed and recommendations for further study on this topic are made in the last section of the chapter.

6.1 Summary

Table 6-1 shows the summary of results for the period of 1952 to 1971. The short-run and long-run elasticities for the single cash crops are quite high except for the estimates of cotton. The relatively low elasticities for the estimates of cotton may be due to two factors: (1) the stronger government control over cotton area planted compared with other cash crops, which is shown by the greater estimates of coefficient of PACt in the cotton area response equation; (2) the nature of cotton as large cash crop in terms of area planted. The results of the study suggest that adjustments of area of single cash crops planted were made possible by both the government and individual farmers (production teams), as shown by the significant estimates of coefficients of both the policy variables and economic variables.

6.2 Conclusions

The estimates for the single cash crops suggest that both the control of government and the response of individual farmers to the relevant economic factors affected the area of single cash crops planted. The high short-run and long-run elasticities indicate sensitivity of Chinese farmers to the changes of relevant prices. The response of farmers within the limit of land allocated only to cash crops is regarded as the response of farmers to the economic factors at micro-level. The adjustments in area of single cash crops planted are affected jointly by government and individual farmers. The effect of government is shown by the control of PAC_t while the effect of farmers is shown by their response to changes of economic factors.

Table 6-1.

A Summary of Results of the Study: The Short-run and Long-run Elasticities (1952-1971)

Name of Crops		Short-run	Long-run
Cotton	(p. r.)[1]	0.32732	0.38093
Tobacco	(p. r.)	0.93742	1.48200
Hemp and Jute	(p. r.)	2.06010	2.51683
Sugar beet	(p. r.)	0.77664	4.14938
Sugarcane	(p. p.)[2]	0.76356	1.06377

Notes: 1. p. r. ---Price ratio used;
2. p. p. ---Producers' price used.

The results would be unexpected to most Chinese planners. The results of response of farmers to the economic factors appear contradictory to Chinese agricultural policy during the period. The tight control of government over agriculture under the centrally-controlled economy of China was not designed to allow the existence of any response of farmers to economic factors. The political education that farmers received from the Party, involving no considerations for oneself and "do whatever the Party asks you to do", would have made the response of farmers impossible. The Party believed in the non-selfish nature of human beings. However, the estimates indicate the existence of the selfish nature of Chinese human beings even under strong political education from the Communist Party.

Today, even though the economic reform in China is still going on, the government would not like to change the nature of the centrally-planned economy of China. The private economy in large scale is not encouraged. The Party still persuades the same political ideology as before. The selfish nature of human beings will never let the system of the central planning work unless what the Party believes becomes true.

6.3 Problems with the Estimations and Suggestions for Further Study on this Topic

Despite the plausible estimates for most equations, some econometric problems still exist with some models. For example, there are some low t-ratios for some coefficients, possibly due to the existence of correlation among the explanatory variables. Different specifications of some variables could be explored, for example, the policy variable and competitive crops, since the estimations are based on the national level. Other cash crops which are not included in the study may have some impact on the cash crops under the study. Regional analysis may offer better estimates.

The ordinary least squares method is used and the Nerlove partial adjustment model is employed for the analysis. The potential for improved estimates by other econometric methods and other economic models, say from testing rational expectations, also exists.

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